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EXAMINER	
VAN, LUAN V	
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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/710,020
Filing Date: June 14, 2004
Appellant(s): HUANG ET AL.

Belinda Lee
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed July 2, 2007 appealing from the Office action mailed January 18, 2007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct. It is noted that the summary is directed to the sole independent claim 1.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6409903	Chung et al.	06-2002
6415974	Jao	07-2002
6030512	Ihara et al.	02-2000

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bojkov et al. in view of Chung et al. and Jao.

Regarding claim 1, Bojkov et al. teach a process for fabricating bumps, comprising the steps of: providing a semiconductor substrate having a plurality of bonding pads 30 (Fig. 2) and a passivation layer 42 thereon, wherein the passivation

layer is disposed on a surface of the semiconductor substrate and exposes the bonding pads; forming a photoresist layer 46 over the semiconductor substrate, wherein the photoresist layer has a plurality of openings and the openings are positioned corresponding to the bonding pads; immersing the substrate into an electrolytic solution (paragraph 14); and performing an electroplating operation by providing a step current to the electrolytic solution (paragraphs 14-15).

Bojkov et al. differ from the instant claim in that the reference teaches a semiconductor substrate but does not explicitly teach the substrate is in the form of a wafer. Bojkov et al. also differ from the instant claim in that the reference does not explicitly teach the openings having different widths or increasing the current.

Chung et al. teach a method and apparatus are provided for the electroplating of a substrate such as a semiconductor wafer which provides a uniform electroplated surface and minimizes burn-through of a seed layer used on the substrate to initiate electroplating. In one aspect of the invention, a current is applied to the anode and cathode substrate which current is preprogrammed to ramp up to a current value from a first current value which current produces a voltage below a predetermined threshold voltage. Electroplated articles including copper electroplated semiconductor wafers made using the apparatus and method of the invention are also provided. (See Abstract, and Fig. 4).

Jao teaches a method of forming bumps having a plurality of openings with various sizes (column 2 lines 38-42).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Bojkov et al. by electroplating the wafer of Chung et al., because a semiconductor substrate is conventionally made in the form of a wafer, and a wafer would be suited for the fabrication of integrated circuit devices. It would have been obvious to one having ordinary skill in the art at the time the invention was made to have further modified the method of Bojkov et al. by increasing the current step as taught by Chung et al., because it would provide a uniform electrodeposited material and would minimize burn-through of a seed layer on the substrate (column 1 lines 46-67 of Chung et al.) It would have been obvious to one having ordinary skill in the art at the time the invention was made to have further modified the method of Bojkov et al. by electroplating the openings with various sizes of Jao, because different sizes of solder bumps can be electroplated to meet the specific input/output characteristics of an integrated circuit device.

Regarding claim 2, the instant disclosure does not teach how the minimum current and the maximum current are determined nor the specific values or ranges of values associated with the minimum current and the maximum current. Based on the instant disclosure, the minimum current is broadly interpreted be any arbitrary current below the lowest starting current, and the maximum current can be any arbitrary current above the highest electroplating current. The step current of Bojkov et al. is between a minimum current, since the current is greater than zero, and below a maximum current, since the current does not go to infinity. Bojkov et al. differ from the instant claim in that the reference does not explicitly teach increasing the current. It would have been

obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Bojkov et al. by increasing the current step as taught by Chung et al., because it would provide a uniform electrodeposited material and would minimize burn-through of a seed layer on the substrate (column 1 lines 46-67 of Chung et al.)

Regarding claim 3, Bojkov et al. teach a plurality of linear currents (see Fig. 5). Linear currents are broadly interpreted to be rectangular current waveforms.

Regarding claim 4, Bojkov et al. teach stopping the current for a brief period (paragraph 5-6).

Regarding claim 5, Bojkov et al. teach the current step comprises a plurality of pulse currents (Fig. 4), each having a peak current 120 and a trough current 122.

Regarding claim 6, Bojkov et al. teach the peak current is between a minimum current, since the current is greater than zero, and a maximum current, since the current does not go to infinity.

Regarding claim 7, Bojkov et al. teach the trough current 120 is a negative current. The representation of the current polarity of Bojkov et al. is the reverse of the instant the invention, because the polarity is viewed from the perspective of the power supply. The current polarity would be reversed if viewed from the perspective of the substrate.

Regarding claim 8, Bojkov et al. teach the current step comprises at least a pulsed current (combination of pulses 120 and 122, Fig. 4) and a plurality of linear currents (pulses 120, Fig. 4).

Regarding claim 9, Bojkov et al. teach the peak current is between a minimum current, since the current is greater than zero, and a maximum current, since the current does not go to infinity.

Regarding claim 10, Bojkov et al. teach the trough current 120 is a negative current.

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bojkov et al. in view of Chung et al., Jao, and further in view of Ihara et al.

Bojkov et al., Chung et al., and Jao teach the method as described above. Bojkov et al. differ from the instant claims in that the reference does not explicitly teach the aspect ratio of the instant claim.

Ihara et al. teach a method of forming bumps wherein the thickness of the resist layer and the diameter of the fine hole are adjusted so that the aspect ratio (height/diameter) of a bump to be formed can be a value not lower than 0.5. Since air can escape smoothly even if the aspect ratio of the bump is not lower than 0.5 or especially even if the aspect ratio of the bump is not lower than 1, plating can be positively carried out in the fine holes. (Column 6 lines 67 -- column 7 line 6).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method of Bojkov et al., Chung et al., and Jao by using the aspect ratio of Ihara et al., because air can escape smoothly (column 6 lines 67 -- column 7 line 6 of Ihara et al.).

(10) Response to Argument

The applicant argues on page 6 of the Appeal Brief that none of Bojkov and Chung raises the issue of forming the bumps by using the photoresist layer having a plurality of openings with different widths. The examiner acknowledges that this may be true. However, independent claim 1 is rejected using Bojkov, Chung and Jao. Therefore, the references taken collectively teach forming the bumps by using a photoresist layer having a plurality of openings with different widths. Furthermore, electroplating bumps having different widths is conventionally known as admitted in the applicant's own disclosure in paragraph 7 under the "Description of the Related Art" section.

The applicant further argues that neither Bojkov nor Chung considers the narrow openings in the photoresist layer would lead to a poor mass transfer of the electrolytic solution and cause non-uniform thickness of the bumps. The examiner acknowledges that this may be true. However, the examiner asserts that the references can be combined for a different reason and do not need to be combined for the applicant's reason. As the Applicant is aware, "there is no requirement that the prior art provide the same reason as the applicant to make the claim invention" (MPEP 2144).

The applicant states that Jao discloses that by either using the various sizes of openings of the UBM layer to control the solder volume or using the various UBM structures to control the height of the solder bumps, or using a combination thereof, the coplanarity of the solder bump structure can be improved; and therefore it would not have been obvious to a skilled artistan to have modified Bojkov with Jao, because Jao's

patent is complete in itself. The examiner respectfully disagrees with this reasoning. The mere fact that Jao is complete in itself to solve the same problem as the applicant's do not preclude Jao from being used to modify another reference. In fact, Jao discloses an explicit reason for using various sizes of openings as stated by the applicant. Therefore, it would have been obvious to one having ordinary skill in the art to have modified the method of Bojkov by electroplating the various sizes of the openings of Jao in order to effectively improve the coplanarity of the solder bumps structure (column 5 lines 40-54 of Jao).

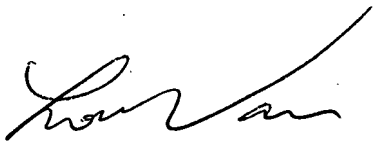
Finally, the applicant further argues that even though Chung provides a concept for a ramping current for plating, replacing the ramping current would ruin the main inventive concept of Bojkov. The examiner notes that modifying Bojkov with the teaching of Chung does not require the bodily incorporation of Chung. In other words, a skilled artistan would be able to keep the pulse current plating sequence, including the relaxation period, of Bojkov while adding Chung's ramping current step. Therefore, modifying Bojkov with the teaching of Chung would not ruin the main inventive concept of Bojkov.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,



Luan V. Van

Conferees:

Nam Nguyen

/Jennifer Michener/

Quality Assurance Specialist, TC1700

Jennifer Michener